The Exergame Enjoyment Questionnaire (EEQ): An Instrument for Measuring Exergame Enjoyment

Alexander Fitzgerald, Sam Huang, Kyle Sposato, Dongjie Wang, Mark Claypool and Emmanuel Agu
Computer Science Dept., Worcester Polytechnic Institute, Worcester, MA 01606
{aefitzgerald, shuang2, kmsposato, dwang2, claypool, emmanuel}@wpi.edu

Abstract

Physical inactivity is on the rise. Exergames provide a new type of exercise that can be appealing to young people and possibly mitigate sedentary lifestyles. However, compliance and player attrition are issues. We assert that monitoring and increasing exergame enjoyment will increase exercise compliance, a view supported by the Social Cognitive Theory (SCT). However, no questionnaires exist to measure player enjoyment of exergames, limiting the ability to monitor and improve exergame use. We created and validated the Exergame Enjoyment Questionnaire (EEQ), a new 20-item questionnaire for measuring how much players enjoyed an exergame. The EEQ was synthesized by combining questions from the Game Engagement Questionnaire (GEQ) and Immersive Experience Questionnaire (IEQ) about the exergames' game elements, and questions from the Physical Activity Enjoyment Scale (PACES) about the physical activity performed in the exergame. The EEQ was refined via focus groups and validated by comparing player responses on the EEQ to their coded responses in free form discussions about their gaming experience. For testing, the Pokemon Go *and* Just Dance Now *exergames were selected. The EEQ score of participants corresponded to 85 percent of their coded responses in free form discussions about their gaming experience, suggesting the efficacy of our instrument. Subjects generally enjoyed* Just Dance Now *more (8 points higher EEQ scores on average) than* Pokemon Go. *However, a t-test suggests that EEQ scores from more subjects are needed in order to conclude that* Just Dance Now *is more enjoyable than* Pokemon Go.

1. Introduction

Physical inactivity is on the rise, especially among young adults [25] who prefer to use electronic media and mobile devices over more active pursuits. Lack of physical activity is linked with an increased risk of various ailments including heart disease, diabetes, cancer and depression [6].

Exergames provide a new type of exercise that can be appealing to young people and possibly mitigate inactivity due to sedentary lifestyles. An exergame is a video game that also provides the game player with some physical activity. Examples include *Just Dance Now* [4], which provides physical activity in the form of dancing and *Pokemon Go* [5], which requires players to walk to certain locations (and hence exercise) in order to catch virtual creatures called Pokemons.

However, consistent use and player attrition are issues with most forms of electronic gaming. Prior work found that 95% of all new game players stop playing within 3 months, and 85% of new players stop after one day [24]. Enjoyment of physical activity has been found to be an important determinant of physical activity levels especially in young people [1]. Hence, we assert that monitoring and increasing exergame enjoyment will increase player compliance. We define exergame enjoyment as "A feeling of pleasure that results from playing a videogame that provides physical activity". Thus, our work focuses on measuring and increasing exergame enjoyment in order to increase exercise compliance. Our focus on increasing enjoyment as a behavior change strategy is supported by the Social Cognitive Theory (SCT), from which perceived enjoyment and social support should contribute to the self-regulation of exercise behavior [22]. SCT suggests that changes experienced and satisfaction with those changes should result in more positive affective responses over time, which should in turn positively impact future exercise behavior.

We envision using the EEQ as ground truth enjoyment label for a Cyber-Physical Recommender System (Cypress) that monitors user enjoyment of exergames played to detect when a user is losing interest in his/her current game, learns the types of exergames each user likes over time and recommends new exergames whenever a gamer becomes disinterested in their current game [26]. This intervention (introducing a new exergame when interest in the old one wanes) has the potential to sustain engagement in exergaming. Creating the EEQ to measure user exergame enjoyment is a necessary first step.

Unfortunately, to the best of our knowledge, there is no existing questionnaire that specifically measures user

URI: https://hdl.handle.net/10125/64158
978-0-9981331-3-3

enjoyment of exergames. Gaming questionnaires such as the Game Engagement Questionnaire (GEQ) [2] and Immersive Experience Questionnaire (IEQ) [3] evaluate the player experience of video games but do not measure user enjoyment of physical activity within video games. Physical activity questionnaires such as the Physical Activity Enjoyment Scale (PACES) [8] – a commonly used measure of enjoyment of physical activity – do not measure player enjoyment of gaming elements as present in exergames.

In this paper, we describe research, synthesis and testing of the Exergame Enjoyment Questionnaire (EEQ), a questionnaire to measure exergame enjoyment. The work described in this paper covers the conceptualization, specification and testing stages of the measure development steps proposed by the Centers for Medicare & Medicaid (CMS) [21] (Figure 1).

The EEQ combines selected physical activity enjoyment questions from the PACES questionnaire with questions about gaming elements selected from the GEQ [2] and IEQ [3]. We also synthesized original questions that attempt to assess certain thought processes and behaviors not tested by the previously created instruments. Original questions were created for the categories of Intrinsically Rewarding Activity, Control and Exercise. We did not create any new questions for Immersion. The EEQ was refined through focus groups, validated in a user study, and then used to evaluate new exergames. Our validated questionnaire had 85 percent agreement with coded responses in free form discussions by participants in focus groups.

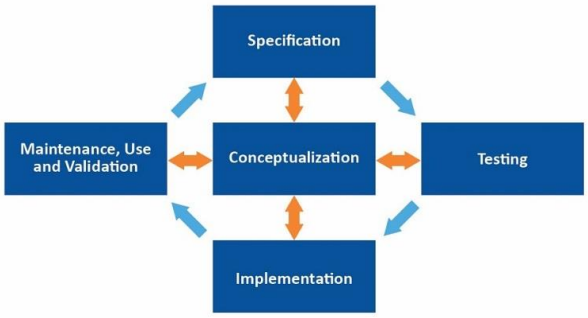

Figure 1: 5 Phases of Measure Development proposed by the Centers for Medicare and Medicaid (CMS)

We believe the EEQ provides a standardized measure of enjoyment across a wide range of exergames, facilitating quantitative comparison, discovery of exergame types liked by various users, and enabling a deeper understanding of user preferences. We envision that the EEQ can be a basis for computational frameworks such as recommender systems that suggest new exergames to users based on other exergames they previously enjoyed [26].

2. Related Work

In prior work, questionnaires have been proposed to measure either exercise enjoyment or game enjoyment, but not both. Prior work includes reviews of game engagement questionnaires and physiological measures [12]. The *Immersive Experience Questionnaire (IEQ)* [15] and *Game Experience Questionnaire (GEQ)* [14, 16] are the most widely used game experience questionnaires [13]. Questionnaires that measure user enjoyment of their physical activity have been proposed, including the *Physical Activity Enjoyment Scale (PACES)* [17]. Questionnaires to measure mood [19] and motivation [18, 20] for exercise have also been proposed. Questionnaire creation, in general, requires careful selection and budgeting of questions [27] with guidance on how to ask questions [28]. As no exergame enjoyment questionnaires exist, in this paper, we synthesize and validate the Exergame Enjoyment Questionnaire (EEQ), a novel exergame enjoyment questionnaire that combines elements of the PACES (exercise) and GEQ and IEQ (gameplay) questionnaires.

3. Methodology

3.1 Exergame Selection Process

While our primary goal was to synthesize and validate an exergame questionnaire, we also wanted to conduct experiments using exergames that were interesting to young adults, representative of exergames available, and reasonably popular. An initial search of the Android and iOS smartphone app markets yielded a list of 80 exergames that we then researched further, played, categorized, and ranked. Next, exergames that were not free, buggy or required only minimal physical activity were excluded. Finally, unpopular games (few ratings or reviews) and those without significant gamification (e.g. step counters) were culled. This elimination process (shown in Figure 2) yielded fourteen exergames, listed in Table 1.

Table 1: Top 14 Exergames Selected

Game	Description
Fitocracy	Personal workout trainer, achievements for workouts, uses social media.
Geocaching	Users walk to locations on real world map to explore Geocaches.
Ingress	Users walk to locations on real world map in a "capture-the-flag" style game.
Just Dance Now!	Users dance to music with on screen dance instructions.
Nike+ Running	Distance/step counter with achievements and goals.

Pokémon GO	Users walk to locations on real world map to catch Pokémon.
Resources Game	Users walk around in a real-world map collecting "resources".
S Health	Personal workout trainer, achievements and goals for workouts.
Shape Up Battle Run	Racing game that requires user to walk, jog, or run with achievements and goals.
SpekTrek Light	Users walk or run in a real-world map and catch in-game "ghosts".
TableZombies Augmented Reality	Augmented reality game that requires user to walk in order to move around within game.
Turf Wars	Users control territories on real-world map and walk/run based on in-game events such as evading police.
Walkr: Fitness Space Adventure	Users walk to explore in-game map and earn achievements and unlocks.
Zombies, Run!	Walking/running game with challenges and achievements.

From this list of fourteen exergames, we selected two exergames for our experiments by applying six selection criteria that captured important attributes and exergame characteristics. The selection criteria included gameplay difficulty, testing difficulty, game elements and physical activity elements. Additional considerations factored into the final exergame selection were the types of physical activity provided and the game popularity. Each of these criteria is now expounded upon.

3.1.1 Exergame Selection Criteria

Drawing upon on previous experience [23], we selected exergames based on:

a. *Game aspects:* In order to succeed in its goal of encouraging players to perform physical activity, exergames must incorporate interesting gamification elements such as fantasy, goal achievement and competition.

b. *Exercise aspects:* An exergame should include adequate physical exertion in order to yield significant health benefits. Exercises in the fourteen considered exergames include walking, running, and dancing, which all involve sufficient exertion.

c. *Testing difficulty:* In order to generate statistically significant results, a large sample size of subjects is needed to play the exergame. To encourage participation, selected exergames should be easy to play and not require extra equipment other than the mobile device.

d. *Gameplay difficulty:* Since subjects must be taught how to play the exergame before they can participate in a user study, learning to play the exergame has to be easy such that first-time exergamers can learn and test it within an hour.

e. *Exercise Types:* Since different subjects have different preferences, it is important to select exergames featuring a diverse range of exercise types. For instance, dancing may be popular with some people while walking/running with others.

f. *Popularity:* We believe that an exergame's popularity correlates with users' interest in playing it. Moreover, experimental results based on popular exergames are likely to have more impact.

3.1.2 Exergames Selected for Evaluation

After applying our game selection criteria, we selected *Pokemon Go* and *Just Dance Now* for our user studies. These games were considered to be representative and had all the desired characteristics from Section 3.1.1. They were also contrasting in their type of activity and interface and could potentially appeal to different types of exergame players (e.g., men versus women). Since prior work had found that female gamers were more likely to enjoy dancing games [23] we included *Just Dance Now*. Since walking games are popular, we included *Pokemon Go.* Moreover, we also wanted to demonstrate the versatility as a measure of exergame compliance and hence the versatility of our EEQ instrument by evaluating diverse exergames types.

a) Pokemon Go

Pokémon Go [5] is a treasure hunt exergame in which players walk to various real-world locations on a map (*Pokestops*) to catch virtual fictional creatures (*Pokemons*) by throwing small spherical balls (*Pokeballs*) at them, and earn achievements. We chose *Pokemon Go* due to its simple but fun gameplay while encouraging walking as a physical activity. The wide-spread popularity of *Pokémon Go* suggests that most potential participants would find it enjoyable, which would help in recruiting subjects for our user study on exergame enjoyment.

a) Just Dance Now

Just Dance Now [4] is a game in which a player dances to a song of their choice while following instructions on a digital display. In multiplayer scenarios, players dance together while following instructions displayed on the same screen. *Just Dance Now* players dance while holding their smartphone in one hand, which tracks their movements via its motion sensors.

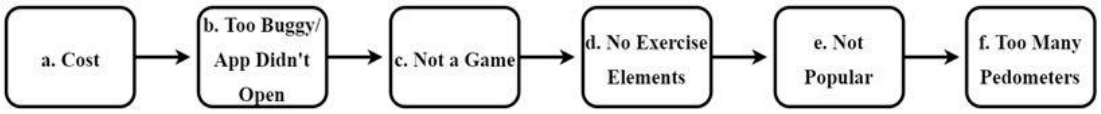

Figure 2: Exergame Elimination Process

Just Dance Now was selected because, in addition to its popularity, it provided dancing, a form of physical activity different than walking to help develop a questionnaire on diverse exergames.

3.2 EEQ Synthesis

An initial draft of the Exergame Enjoyment Questionnaire (EEQ) was generated by selecting gaming-related questions from the GEQ and IEQ and questionnaires about the physical activity in the exergame from the Physical Activity Enjoyment Scale (PACES) [8]. The IEQ measures the immersive experience of a game while the GEQ measures four components of engagement: absorption, flow, presence and immersion [2]. PACES is a questionnaire that examines the feelings of users pertaining to physical activity [8]. Questions are in four categories: immersion, intrinsically rewarding activity, control and exercise. Questions in the first three categories measure player enjoyment of game elements of the exergame, while the fourth category measures the players' enjoyment of the physical activity provided by the exergame.

Immersion is defined as "being deeply engaged or involved in the game-playing experience while retaining some awareness of one's surroundings" [2]. Intrinsic reward is an outcome that gives the player satisfaction from demonstrating skill and competence in overcoming the games challenges [9]. Control relates to a sense of how much the player can directly influence the exergame's outcome. Exercise refers to the physical activity that the exergame's players are required to perform.

We also synthesized original questions that attempt to test for certain thought processes and behaviors not tested in the previously created questionnaires. Original questions were created for the categories of intrinsically rewarding activity, control and exercise. For immersion, we adapted questions from the IEQ and GEQ and did not create any new questions.

Table 2 summarizes the twenty questions in our Exergame Enjoyment Questionnaire (EEQ). In the final questionnaire, the question order is randomized to prevent consecutive questions being from the same category, so users are less likely to answer without thinking about their responses. Subjects responses are in a five-point Likert scale: strongly disagree, disagree, neutral, agree, and strongly agree. Questions 4, 6, 10, 11, 13, 19 and 20 are negatively phrased to ensure that positive scores on the questionnaire corresponded to more enjoyment and higher EEQ scores. The final EEQ questionnaire as presented to users after randomization is shown in Figure 3.

Table 2: Exergame Enjoyment Questionnaire Categories of Questions.
Letter in parentheses indicates source of Question (G = GEQ, I = IEQ, P = PACES and O = Original)

	EEQ Question (Source Questionnaire)
Immersion	1. I did not feel like I wanted to keep playing. (G)
	2. I felt like I lost track of time while playing. (G)
	3. I felt a strong sense of being in the world of the game to the point that I was unaware of my surroundings. (I)
	4. I felt emotionally attached to the game. (I)
	5. I was focused on the game. (I)
Intrinsically Rewarding Activity	1. I felt that this game provided an enjoyable challenge. (O) 2. I felt a sense of accomplishment from playing the game. (O) 3. I did not feel a desire to make progress in the game. (I)
Control	1. I felt that it was easy to familiarize myself with the game controls. (O)

	2. I felt that it was difficult to understand how the game works. (O) 3. I felt in control of the game. (O) 4. I felt that the game reacted quickly to my actions. (O)
Exercise	1. I consider playing the game "exercise". (O) 2. I felt that the game would have been more enjoyable without physical activity. (O) 3. The exercise in this game made me feel good. (P) 4. I felt excited about the physical activities in the game. (P) 5. I felt that playing the game was beneficial for my physical well-being. (P) 6. I would rather not be exercising, even though the exercise was accompanied by game elements. (P) 7. I would prefer that this physical activity was not accompanied by game elements. (O) 8. I felt that the physical activity was too intense for me. (O)

Exergame Enjoyment Questionnaire

For each of the statements below, please circle how much you agree or disagree with the statement. i.e. select

Strongly Disagree Disagree Neutral Agree Strongly Agree

1. I felt excited about the physical activities in the game.
2. The exercise in this game made me feel good.
3. I felt like I lost track of time while playing
4. I felt that it was difficult to understand how the game works.
5. I was focused on the game.
6. I felt that the game would have been more enjoyable without physical activity.
7. I felt that it was easy to familiarize myself with the game controls.
8. I felt emotionally attached to the game.
9. I consider playing the game "exercise".
10. I felt that the physical activity was too intense for me.
11. I did not feel a desire to make progress in the game.
12. I felt a strong sense of being in the world of the game to the point that I was unaware of my surroundings.
13. I would rather not be exercising, even though the exercise was accompanied by game elements.
14. I felt that playing the game was beneficial for my physical well-being.
15. I felt that this game provided an enjoyable challenge.
16. I felt a sense of accomplishment from playing the game.
17. I felt that the game reacted quickly to my actions.
18. I did not feel like I wanted to keep playing.
19. I would prefer that this physical activity was not accompanied by game elements.
20. I felt in control of the game.

Figure 3: Final EEQ Presented to Subjects after Randomization of Question Order

3.3 Focus Groups to Refine EEQ

As part of testing process, IRB-approved focus groups were conducted to eliminate ambiguous wording and remove questions that subjects were not able to understand. Each focus group procedure involved five steps: 1) Sign informed consent form, 2) Administer pre-questionnaire, 3) Play game (*Pokémon GO* or *Just Dance Now*) for thirty minutes, 4) Administer Exergame Enjoyment Questionnaire (EEQ), and 5) Discuss focus group conversation questions. Multiple focus groups were carried out, iteratively refining the EEQ until a stable version was realized (saturation). Details now follow.

3.3.1 Pre-Questionnaire

Each subject responded to a pre-questionnaire before playing each exergame and then filled out the EEQ after

playing. The pre-questionnaire asked demographic questions (e.g., age and gender), prior exergaming experiences and how much exercise participants performed on average each week. The pre-questionnaire was administered in order to place subjects into sub-groups for retrospectively investigating whether certain sub-populations tended to give certain types of responses. For example, sub-grouping could determine whether participants new to exergames generally found them enjoyable because of their novelty. Participants responded to the EEQ after each game session. The final 20 question EEQ had answers on a 1-5 ("Strongly Agree" to "Strongly Disagree") Likert scale. The scores for all 20 questions were tallied to give a total score out of 100 per game.

3.3.2 Game Testing Procedures

Each game testing session lasted for at most one hour. Each testing session began with 30 minutes of gameplay that followed specific instructions, after which the EEQ was administered. Each participant was given an Android smartphone to play each game, with *Just Dance Now* also having dance instructions displayed on a large screen. Before playing each exergame, we gave subjects specific game objectives.

Pokemon Go testing: While *Pokemon Go* players were not restricted to walking along specific paths, they were limited to exploring an area of about half mile radius around the WPI campus. Within this area, players were required to visit 10 *Pokestops* in order to ensure that players actually moved. Figure 4 shows the instruction sheet (with map) given to subjects.

Instructions

- Return within a half hour of the starting time.
- Stay within the red boundary shown above.
- Visit at least 10 PokéStops.
- Catch Pokémons that appear.

Figure 4: Map and Pokemon Go Instruction Sheet given to Subjects

Just Dance Now testing: Two players danced to each song side by side in a room while a large screen displayed directions on the game's dance motions (Figure 5). Each player was given an Android smartphone and the players danced for a duration of 30 minutes. A proctor observed that players were reasonably active throughout the testing period. Participants were instructed to play the game at their own pace and intensity but were instructed to play the game without breaks for the entire thirty minutes.

Figure 5: Participants Playing *Just Dance Now*

3.3.3 Focus Group Questions

The last part of the focus group was a discussion with participants about their exergaming experience. At this point, the goal was to gather participants' opinions about the EEQ or study methodology and fix any issues discovered. The following questions were prompting questions used to initiate focused discussions between the participants and the researchers.

1. How do you feel about the game?
2. Would you play this game again?
3. What do you think about the physical activity in this game?
4. While playing, did you reach any goals, achievements or accomplishments?
5. Was there anything you did not like about the game?
6. Did anything interrupt your gameplay?
7. Did you have any problems while taking the questionnaire?

3.4 EEQ Testing

The goal of testing the EEQ was to generate quantitative evidence whether or not the EEQ yielded reliable data on user exergame enjoyment. In an IRB-approved study, a larger group of participants played the two exergames selected for evaluation (*Pokemon Go* and *Just Dance Now*) for approximately thirty minutes each, after which they filled out the draft EEQ. Finally, they were asked

open-ended questions to seed a discussion about their exergame experience.

Transcripts of participants' free form discussion in response to each EEQ question were analyzed using a peer-review process (i.e., multiple peers reviewed each transcript and compared results). Key phrases were picked out and categorized (coded) as either *agreeing* with their Likert scale response on the EEQ, *disagreeing* or *no evidence* found either way.

3.5 Analysis of EEQ Scores for Both Exergames

The scores generated from the validated EEQ provided ground truth on how much subjects enjoyed each game including their levels of immersion, control, activity and reward. We analyzed the EEQ scores gathered from subjects' responses after playing *Just Dance Now* and *Pokemon Go*, including final EEQ scores as an indication of enjoyment level, discovering differences in how players enjoyed each game.

4. Results

4.1 Focus Groups to Refine EEQ

Thirty-eight (58%) females and 16 males (42%), all college students between the ages of 18-22, participated in the focus groups. Twenty-three participants had never heard of exergames, while 15 of them had. Subjects reported exercising an average of about 6 hours weekly.

Methodology Revisions: For *Pokemon Go*, to avoid participants' disconnection from the campus Wi-Fi network, participants' movements were limited to areas with good Wi-Fi signal strength. We also discovered that players who reached different levels of *Pokemon Go* had different gaming experiences. To ensure that participants had the same experiences, players were required to start each game from a new account rather than from where the last person left off. For *Just Dance Now*, based on early feedback, we increased player enjoyment by allowing users to choose any songs available from the game's catalog and to play in pairs rather than alone.

Questionnaire Revisions: Based on focus group findings, we also reworded questions to clarify their intent, substituted words that had ambiguous meanings and removed questions that participants were not sure how to respond to.

4.2 EEQ Testing

Twenty-three new participants were recruited and participated in our *Just Dance Now* EEQ testing studies, while 15 subjects participated in our *Pokemon Go* testing studies. Figure 6 shows the agreement percentage per question on the EEQ (data for *Pokemon Go* and *Just Dance Now* combined). An average (mean) of 85 percent of coded responses agreed with the subjects' statements in focus group discussions, effectively validating the EEQ.

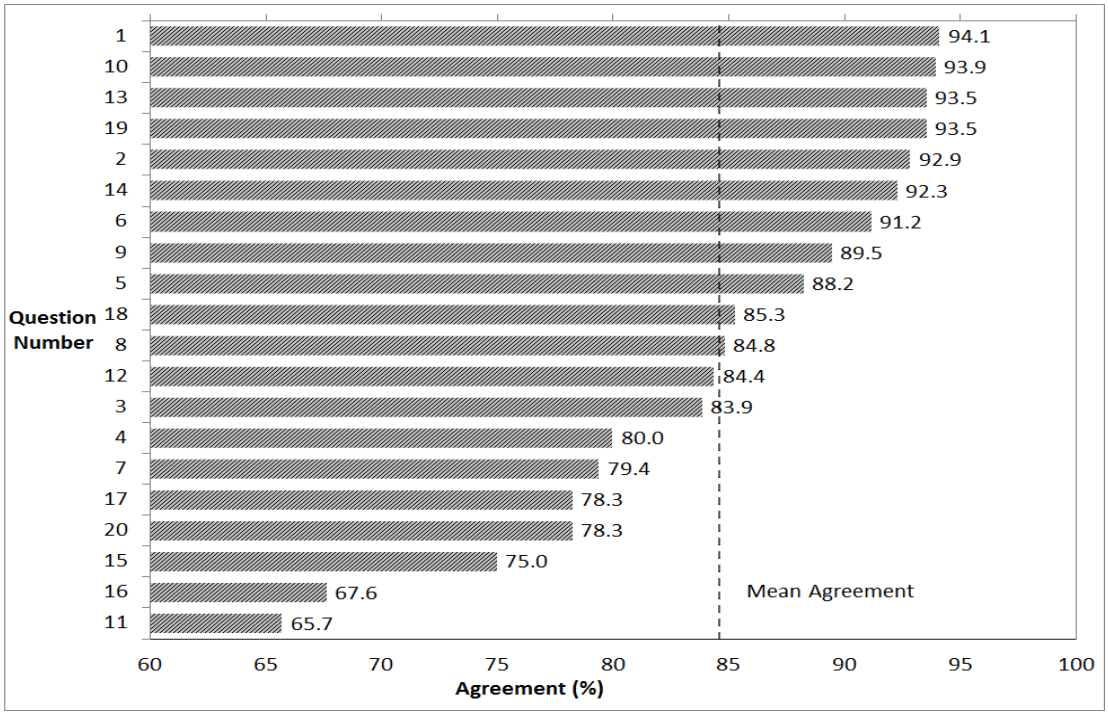

Figure 6: Agreement Percentage per Question Sorted by Agreement Percentage (greatest to least)

4.3 Analysis of EEQ Scores for Both Exergames

4.3.1 Pokemon Go Enjoyment Score Analysis

The resultant enjoyment scores calculated by the EEQ scoring had a range from 54 to 78 for *Pokemon Go* (with a minimum possible score of 20 and a maximum possible score of 100). The average enjoyment score was about 67. Figure 7 shows the distribution of enjoyment scores for all 15 *Pokemon Go* subjects and Figure 8 shows the cumulative probability of the enjoyment scores for *Pokemon Go*.

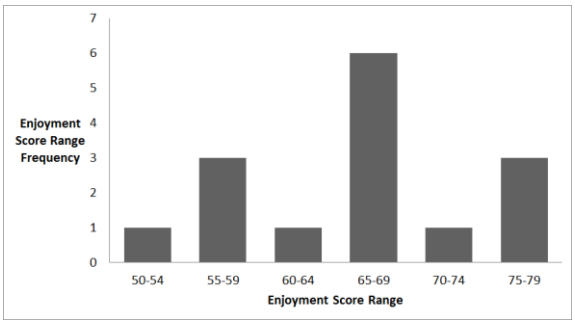

Figure 7: Enjoyment Score Distribution for *Pokémon Go*

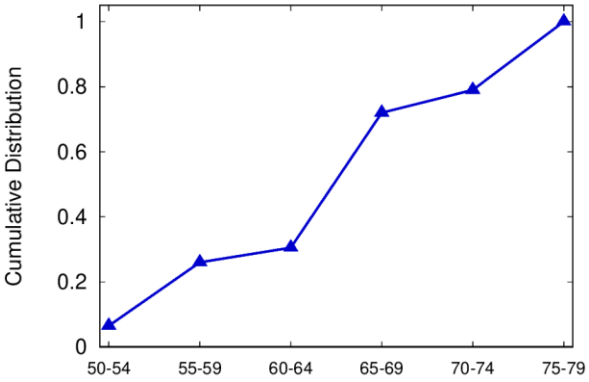

Figure 8: Cumulative Distribution of Enjoyment Scores for *Pokémon Go*

4.3.2 Just Dance Now Enjoyment Score Analysis

The resultant enjoyment scores calculated by the EEQ scoring rules ranged from 59 to 96 for *Just Dance Now*. The mean enjoyment score was about 75. Figure 9 provides the distribution of enjoyment scores from all 23 participants, and Figure 10 displays the cumulative distribution of their scores.

4.3.3 Comparison of EEQ Scores for both games

Overall, based on EEQ scores, participants found *Just Dance Now* more enjoyable than *Pokemon Go*, depicted by higher overall EEQ scores as well as higher EEQ scores for each category of questions as shown in Figure 11. The lower EEQ score might be because several *Pokemon Go* players complained about having technical issues such as Wi-Fi disconnections which ultimately impacted their enjoyment of the game. However, a t-test suggests that EEQ scores from more subjects are needed in order to conclude that *Just Dance Now* is more enjoyable than *Pokemon Go*. We found almost no correlation between exergame enjoyment and participants' level of exercise per week (R = 0.0007).

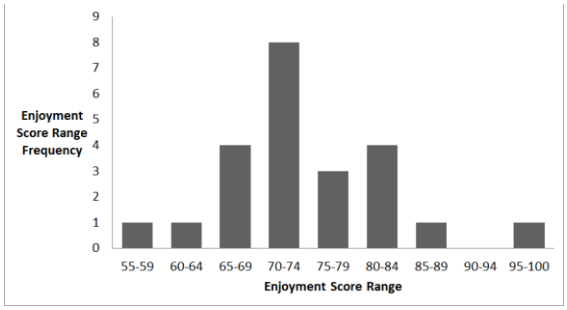

Figure 9: Enjoyment Score Distribution for *Just Dance Now*

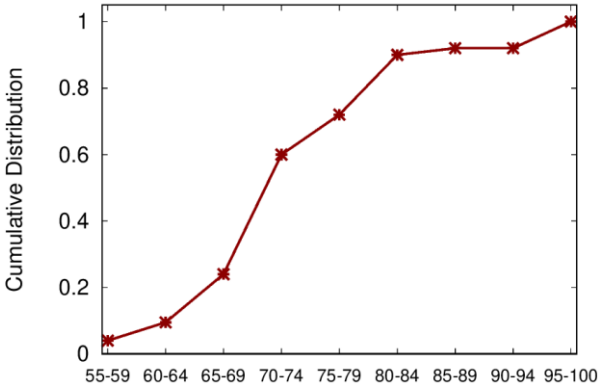

Figure 10: Cumulative Distribution of Enjoyment Score for *Just Dance Now*

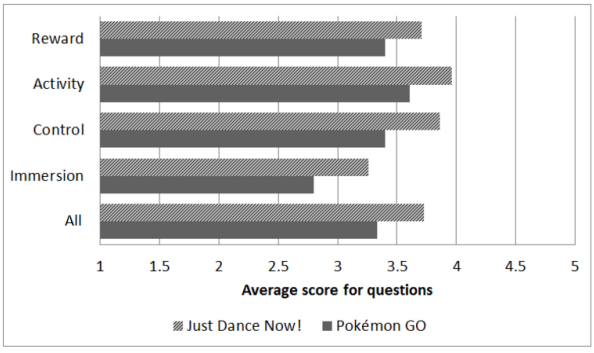

Figure 11: Comparison between Mean Score for each Category of EEQ Questions for Both Games

5. Discussion

Not only did the EEQ have a high average agreement percentage per question (of ~85%), but the highest scores on the EEQ seemed consistent with the players that expressed the most joy during the post-game conversation. The highest scores all came from participants who had played *Just Dance Now*. These top scoring participants seemed to really enjoy the game. For that reason, the EEQ appears to be effective for identifying those players who enjoy the exergame the most. Unfortunately, there is no obvious correlation between the medium- or low-scoring participants and the joy that they expressed afterwards.

The overall sample size of 38 players is, in general, a reasonable sample size for statistical significance. However, when split between two games, a total sample size of 60 players or more (more than 30 per game) would have allowed for more robust conclusions to be drawn. In particular, the enjoyment data is also affected by some users' past experiences with the games. For example, multiple *Pokemon Go* participants stated that they had played the game a lot prior to the testing session. It is possible that they enjoyed the game less because they had already played it - some former *Pokemon Go* players even admitted that they had become bored with the game. If the EEQ was tested for different exergames that people were less familiar with, then the enjoyment data may be more consistent.

The average enjoyment score for players who played *Just Dance Now* with other participants was 0.73. The average enjoyment score for players who played *Just Dance Now* alone was 0.79. The evidence suggests that it is more fun to play the game alone, however, these sample sizes are low with fewer than ten players playing solo. Furthermore, the top two highest scoring participants also happened to play alone; this could have contributed to a slightly misleading result. Understanding the relationship between enjoyment and number of players will require additional testing. From the post-game discussions, some players feel uncomfortable dancing alone in front of the test proctors and would prefer company. However, other players have said that they are glad they played alone for fear of embarrassing themselves in front of other players. It is unclear if enjoyment and number of players are strongly related.

6. Conclusion and Future Work

Enjoyment of physical activity has been found to be an important determinant of physical activity levels especially in young people. Prior questionnaires measure either physical activity or player engagement in computer games but neither alone captures enjoyment of exergames which combine both video game and physical activity elements. We synthesized and validated the 20-item Exergame Enjoyment Questionnaire (EEQ), a novel instrument for measuring how much players enjoyed an exergame. The EEQ combines select questions from the GEQ and IEQ about the exergame's gaming elements, select questions from PACES about the physical activity performed in the exergame, and 10 original questions capturing the essences of exergames. Player EEQ scores for *Pokemon Go* and *Just Dance Now* corresponded with 85 percent of coded responses in free form discussions about their gaming experiences. Players EEQ scores for *Just Dance Now* were on average 8 points higher (slightly more enjoyment) than *Pokemon Go*, although additional testing is needed to definitively compare enjoyment. The EEQ can be a valuable tool for quantitatively assessing player enjoyment of exergames, for use in systems that might strive for greater adherence in players to exercise. The EEQ may also facilitate discovery of determinants of exergame enjoyment and overall a deeper understanding player preference.

Although the results presented here are promising, they are a work in progress – future work of item reduction and scale evaluation (including dimensionality, tests of reliability and tests of validity) are needed. In addition, our intent is to gather more data and on a broader scale to continue assessing the effectiveness of the EEQ as an instrument. We are also exploring using the EEQ as a basis for an exergame recommender system [26].

Acknowledgments

We would like to thank Hope Wallace for conducting initial assessment and ranking of exergames, from which we based our exergame selection.

6. References

[1] R W Motl, R K Dishman, R Saunders, M Dowdad, G Felton and R R Pate, "Measuring Enjoyment of Physical Activity in Adolescent Girls", *American Journal of Preventive Medicine*, Volume 21, Issue 2, August 2001, pages 110-117.

[2] J H Brockmyer, F M Christine, K A Curtiss, E McBroom, K M Burkhart, J N Pidruzny, "The Development of the Game Engagement Questionnaire: A Measure of Engagement in Video Game-playing. Response to Reviews." *Journal of Experimental Social Psychology* 45 (2009) 624–634, 12 Mar. 2009.

[3] A L Cox, C Jennett, C Paul, S Dhoparee, A Epps, T Tijs, A Walton, "Measuring and Defining the Experience of Immersion in Games". *International Journal of Human-Computer Studies*, Vol. 66, No. 9 (2008)

[4] *Just Dance Now*. 1.5.1. Ubisoft. 2014. Video Game.

[5] *Pokémon GO*. 0.39.1. Niantic Labs. 2016. Video Game

[6] J A Mcveigh, A H Elisabeth, E K Winkler, M S Howie, A S Tremblay, A A Rebecca, P R. Eastwood, G N. Healy, and L M. Straker. "Objectively Measured Patterns of Sedentary Time and Physical Activity in Young Adults of the Raine Study Cohort." *International Journal of Behavioral Nutrition and Physical Activity* 13.1 (2016).

[7] J B Moore, Z Yin, J Duda and B Gutin, "Measuring Enjoyment of Physical Activity in Children: Validation of the Physical Activity Enjoyment Scale." *Journal of Applied Sport Psychology*, Volume 21, S1 (2009)

[8] S P Mullen, P et al. "Measuring Enjoyment of Physical Activity in Older Adults: Invariance of the Physical Activity Enjoyment Scale (paces) across Groups and Time." *The International Journal of Behavioral Nutrition and Physical Activity*, Volume 8 (2011).

[9] I A Nordin, A Denisova, and P Cairns. "Too Many Questionnaires: Measuring Player Experience Whilst Playing Digital Games." In *7th York Doctoral Symposium on Computer Science and Electronics*, October 2014.

[10] A E Staiano, and S L. Calvert. "Exergames for Physical Education Courses: Physical, Social, and Cognitive Benefits." *Child Development Perspectives*. The Society for Research in Child Development, May 2011.

[11] R Swatman, "Pokémon Go Catches Five New World Records." *Pokémon Go Catches Five New World Records*. Guinness World Records, 10 Aug. 2016. Web. October 8, 2016.

[12] E.D. Mekler, J.A. Bopp, A.N. Tuch, and K. Opwis, "A Systematic Review of Quantitative Studies on the Enjoyment of Digital Entertainment Games", In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (CHI), ACM, New York, NY, USA, pages 927-936, 2014.

[13] A.I. Nordin, A. Denisova, and P. Cairns, "Too Many Questionnaires: Measuring Player Experience Whilst Playing Digital Games", In *7th York Doctoral Symposium on Computer Science and Electronics (YDS)*, York, United Kingdom, 2014.

[14] J.H. Brockmyer, C.M. Fox, K.A. Curtiss, E. McBroom, K.M. Burkhart, and J.N. Pidruzny. "The Development of the Game Engagement Questionaire: A Measure of Engagement in Video Game Playing", *Journal of Experimental Social Psychology*, Vol. 45, pages 624-634, 2009.

[15] C. Jennett, A. L. Cox, P. Cairns, S. Dhoparee, A. Epps, T. Tijs, and A. Walton, "Measuring and Defining the Experience of Immersion in Games", *International Journal of Human-Computer Studies*, Vol. 66, No. 9, pages 641-661, 2008.

[16] K. Poels, W. Ijsselsteijn and Y. de Kort, "Development of the Kids Game Experience Questionnaire: A Self-report Instrument to Assess Digital Game Experiences in Children", In *Proceedings of the Meaningful Play Conference*, East Lansing, Michigan, MI, October 9-11, 2008.

[17] R.W. Motl, R.K. Dishman, R. Saunders, M. Dowda, G. Felton, and R.R. Pate, "Measuring Enjoyment of Physical Activity in Adolescent Girls", *American Journal of Preventive Medicine*, Volume 21, pages 110-117, 2001.

[18] D. Markland and V. Tobin, "A Modification to Behavioural Regulation in Exercise Questionnaire to Include an Assessment of Motivation", *Journal of Sport and Exercise Psychology*, Volume 26, pages 191-196, 2004.

[19] D.M McNair, M. Lorr and L.F. Droppelman, "Manual for the Profile of Mood States", *Educational and Industrial Testing Services*, San Diego, California, 1971.

[20] D. Markland and L. Hardy, "The Exercise Motivations Inventory: Preliminary Development and Validity of a Measure of Individuals' Reasons for Participation in Regular Physical Exercise", *Personality and Individual Differences*, Vol. 15, No. 3, pages 289-296, 1993.

[21] Centers for Medicare & Medicaid, Measure Development by Phase, https://www.cms.gov/Medicare/Quality-Initiatives-Patient-Assessment-Instruments/MMS/Measure-Development-by-Phase.html. Accessed June 12, 2019

[22] Sean Mullen, E Olson, S Phillips, A Szabo, T Wójcicki, E Mailey, N Gothe, J Fanning, A Kramer and E McAuley, "Measuring enjoyment of physical activity in Older Adults: Invariance of the Physical Activity Enjoyment Scale (PACES) Across Groups and Time", *Interlational Journal of Behavioral Nutrition and Physical Activity*, Volume 8, Number 103, 2011.

[23] E. Agu, A. Chokchaisiripakdee, N. Sujumnong, L. Krachonkitkosol, B. Tulu, "Making Exergames Appealing: An Assessment of Commercial Exergames", in *Handbook of Research on Holistic Perspectives in Gamification for Clinical Practice*, IGI Global, 2015.

[24] Playnomics, "Quarterly US Player Engagement Study", Q3 Jul.-Sep., 2012.

[25] Emily Guskin. "Teenagers are Fueling a Competitive Gaming Tidal Wave", *The Washington Post*, March 9, 2018.

[26] E. Agu and M. Claypool. "Cypress: A Cyber-Physical Recommender System to Discover SmartPhone Exergame Enjoyment", In *Proceedings of the ACM Workshop on Engendering Health with Recommender Systems*, Boston, MA, USA, September 15, 2016.

[27] FluidSurvey's Team, "Finding the Correct Survey Length", *FluidSurveys*, August 7, 2013.

[28] S. Beadell. "Surveys 101: A Simple Guide to Asking Effective Questions." *Zapier - The Ultimate Guide to Forms and Surveys*. September 11, 2016.